(12) UK Patent Application (19) GB (11) 2 246 975 (13) A

(43) Date of A publication 19.02.1992

(21) Application No 9018187.6

(22) Date of filing 18.08.1990

(51) INT CL[5]
B23H 7/26

(52) UK CL (Edition K)
B3V VEEB V101

(56) Documents cited
GB 2080176 A

(58) Field of search
UK CL (Edition K) B3V
INT CL[5] B23H

(71) Applicant
Rolls-Royce plc

(Incorporated in the United Kingdom)

65 Buckingham Gate, London, SW1E 6AT, United Kingdom

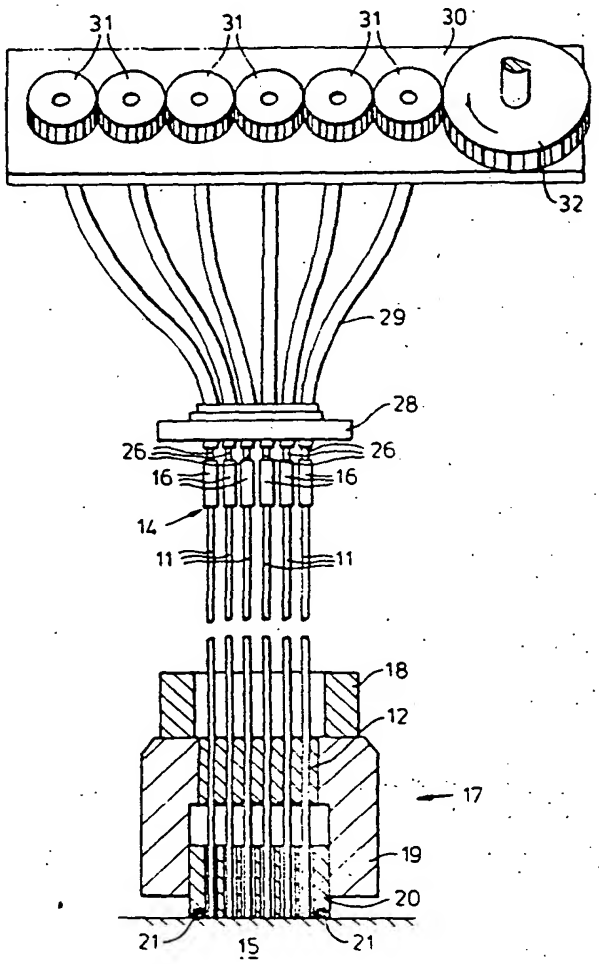
(72) Inventor
Stuart Apsley Bridges

(74) Agent and/or Address for Service
T C Jennings and V J Bird
Rolls-Royce plc, Patents Department, Derby, DE2 8BJ, United Kingdom

(54) Multi-electrode rotation in electrical discharge machining

(57) An apparatus for electrical discharge machining comprises a number of electrodes 11, positions of which relative to the work piece form a machining gap, a supply of dielectric fluid for the machining gap, a power supply to produce machining pulses for electrical discharge machining, and a flexible drive system comprising a number of flexible drive members 29 coupled to respective electrodes and driven so as to rotate the drive members and each electrode about its longitudinal axis.

Fig.1.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

Fig.1.

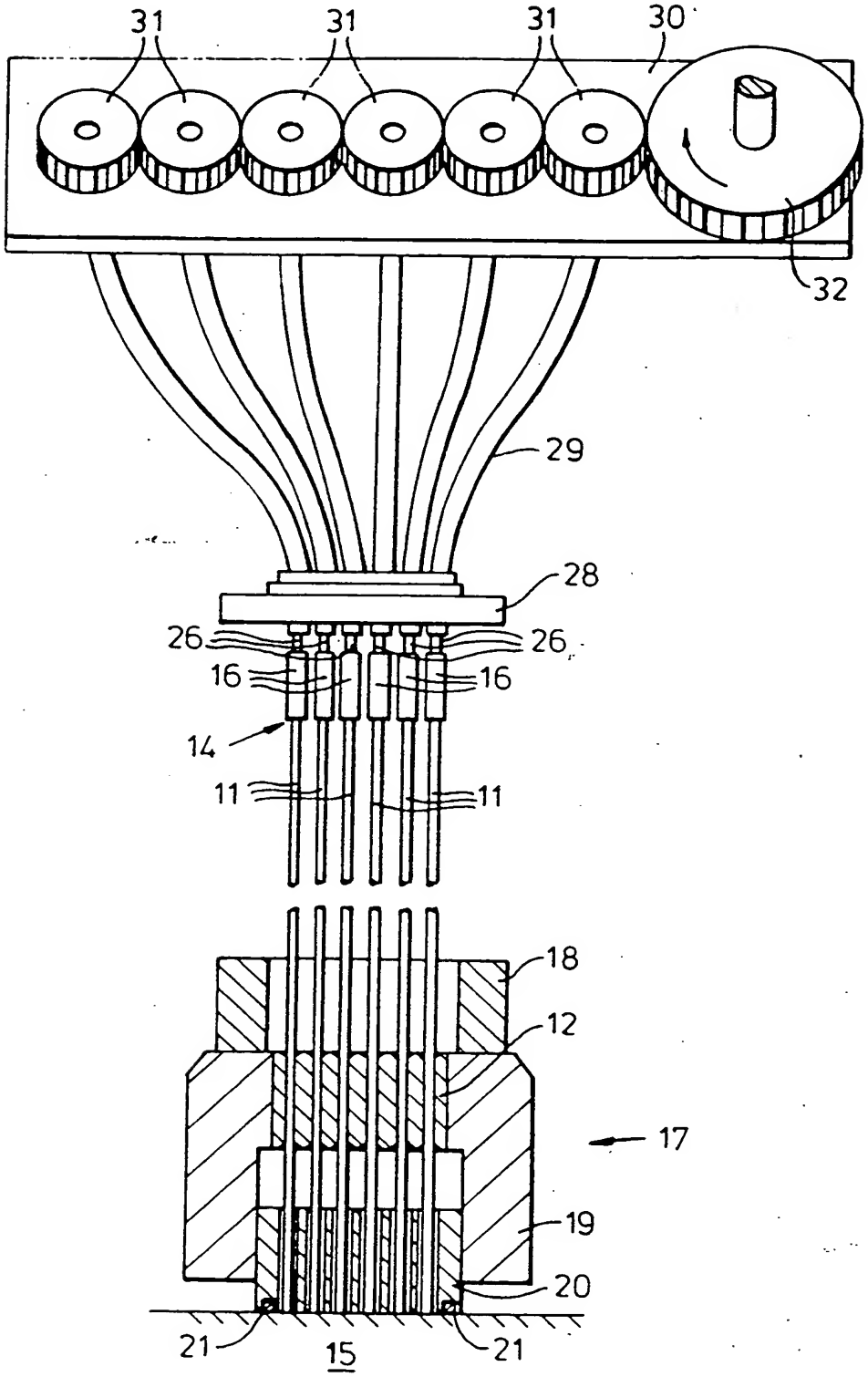


Fig. 2.

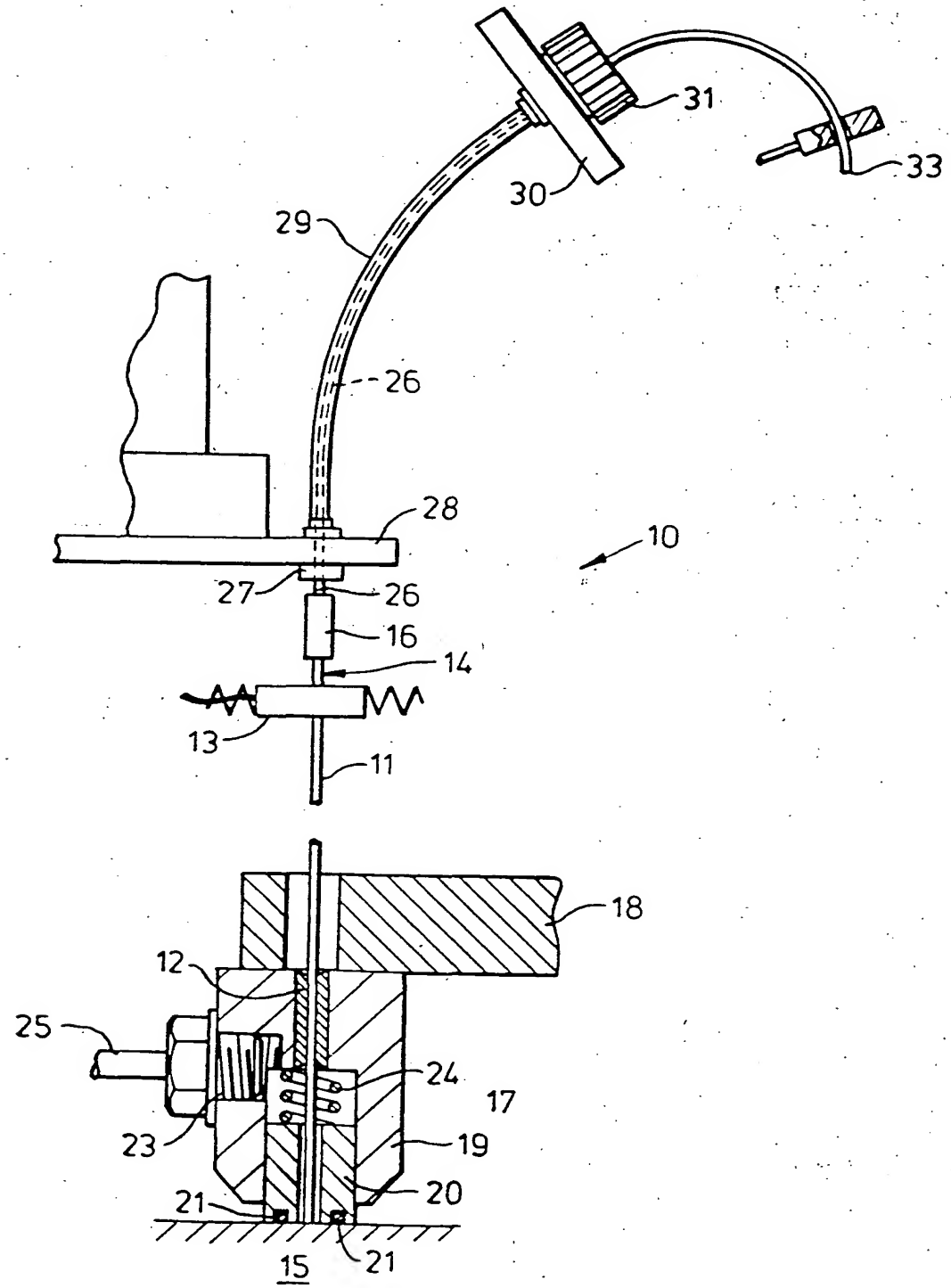
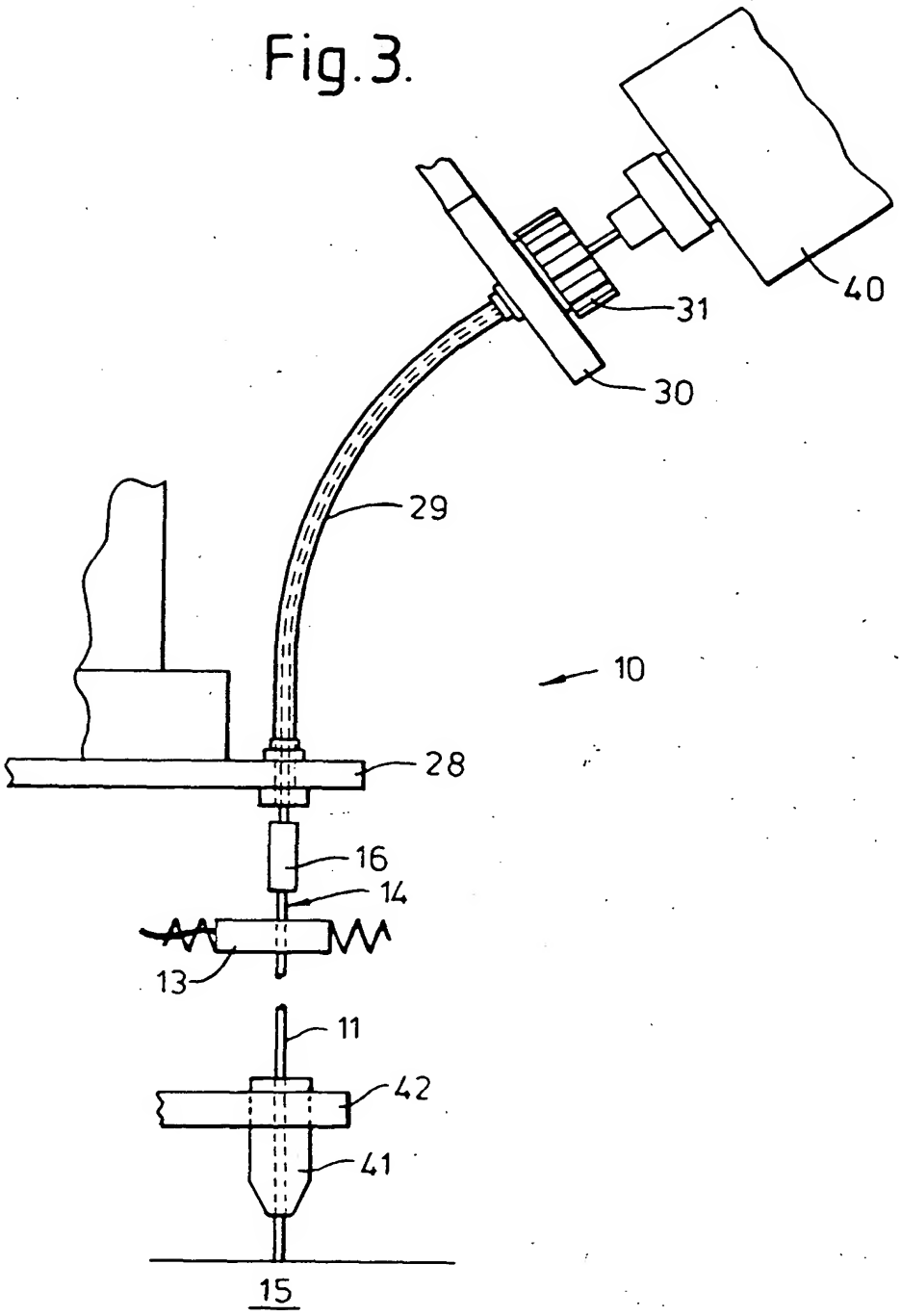


Fig.3.



MULTI-ELECTRODE ROTATION IN ELECTRICAL DISCHARGE MACHINING

This invention relates to electrode rotation in electrical discharge machining (EDM).

When drilling a hole using EDM, particularly but not exclusively a small diameter, deep hole, it is known that rotation of the electrode improves both machining speed and hole surface quality.

However, in simultaneous multi-hole drilling the close pitch generally required between holes has made the design of a rotation system difficult. This is because size and space limitations preclude the use of conventional electrode clamping mechanisms such as collets or three jaw chucks.

According to a first aspect of the present invention there is provided a flexible drive system for use in multi-electrode electrical discharge machining wherein the drive system comprises a plurality of flexible drive members for coupling to respective electrodes and drive means for rotating the drive members and each electrode about its longitudinal axis.

Preferably the flexible drive members are tubular for use with tubular electrodes to allow the passage of dielectric fluid therealong.

Conveniently one end of each drive member is secured to one end of a connecting sleeve, the other end of which is adapted to receive a respective electrode.

According to a second aspect of the present invention

there is provided apparatus for electrical discharge machining comprising a plurality of electrodes, the positions of which relative to the work piece are adjustable to form a machining gap, dielectric supply means for supplying dielectric fluid into the regions of the machining gap, power supply means connected in use between the electrodes and the work piece and arranged when operative to produce machining pulses for electrical discharge machining and a flexible drive system comprising a plurality of flexible drive members for coupling to respective electrodes and drive means for rotating the drive members and each electrode about its lengthwise axis.

Embodiments of the present invention will now be described by way of example in more detail. The description makes reference to the following diagrammatic drawings in which:

Figure 1 is a part sectional front view of a multi-electrode machine head of an EDM machine tool incorporating a drive system according to the present invention;

Figure 2 is a part sectional side view of the arrangement shown in figure 1; and

Figure 3 is a part sectional view of another multi-electrode machine head of an EDM machine tool incorporating another drive system according to the present invention.

In figures 1 and 2 is shown a machine head 10 of an EDM machine tool. The machine head 10 incorporates in this example six tubular electrodes 11 each of which is retained in an associated insulated guide bush 12. The

electrodes are electrically connected to an electrical input 13 in a conventional manner and the ends 14 of the electrodes remote from the work piece 15 are connected to a series of connections 16 in the form of connection sleeves.

The connectors 16 are in this example formed of "memory metal" which is a commercially available nickel-titanium alloy. If the alloy is mechanically deformed at a temperature below a specific temperature then it will return to a predetermined shape when the temperature is raised. In the embodiment, when the memory metal connectors 16 are cooled below a certain temperature they will expand to permit assembly to the electrodes 11. When the temperature is raised the connectors will contract and grip the electrodes to provide a compact and pressure coupling.

The guide bushes 12 are incorporated in a flow adaptor 17 carried by a clamp arm 18 which adaptor comprises an upper sleeve 19 and a lower sleeve 20 slidably mounted therein. The lower sleeve 20 has an annular sealing element 21 for sealing the adaptor 17 with respect to the work piece 15. A port 23 is provided in the upper sleeve 18 to allow the introduction into chamber 24 of pressurised dielectric fluid from a supply line 25. This fluid acts on the lower sleeve and supplements a spring 34 to urge the sealing element 21 into tight sealing engagement with the work piece 22. The fluid is able to flow into the machining gap to pick up machining debris and the fluid and debris are then discharged along the bore of the electrodes 11.

Also connected to each connectors 16 is a flexible drive tube 26 which passes throat a thrust collar 27 attached to a support arm 28 of the machine head. Above the arm

28 the drive tube 26 is protected by a sheath 29. Each drive tube 26 extends to a gear support plate 30 and is connected to an associated rotary drive gear 31 for rotation therewith. The drive gears are interengaged with each other, in this case in series, and are driven by a main gear 32 driven by suitable known motor and control means which are not shown. The drive tubes 26 are connected through the gears 31 to respective flexible drain tube 33.

The other general features of a conventional EDM machine tool have not been shown or described, such as means for adjusting the position of the electrode with respect to the work piece to form the machining gap, power supply means for connection between the electrode and the work piece and control means, such general features being known in the art.

In operation therefore the dielectric fluid introduced to the machining gap by the flow adapted 17 and is discharged through the bore of the electrodes which are coupled for rotation during machining with the flexible drive tubes by virtue of the connectors 16. The fluid is then discharged out of the flexible drain tubes.

In the figure 3 embodiment, similar items have been given similar reference numerals. In this arrangement however, dielectric fluid is passed down each electrode 11 (only one shown) into the region of the machining gap. For this arrangement a rotary pressure coupling 40 is attached to the drive tubes 26 though the series of drive gears 31, in place of the drain tubes 33 of figures 1 and 2, for the purposes of supplying high pressure dielectric fluid. The flow adaptor 17 is therefore not required and is replaced by insulated guide bushes 41 attached to a support arm 42.

In operation therefore the dielectric fluid is introduced to the machining gap along the bore of the electrodes 11 which are coupled for rotation about their longitudinal axes during machining with the flexible drive tubes by virtue of the connectors 16.

The flexible drive tubes enable the series of electrodes 11 to be driven in rotation. A mechanism for such a feature could not be accommodated in the small spacings in between the electrodes 11 where it is only possible to fit the "memory metal" couplings because the pitch distance is too small. Also the actual drive mechanisms can be spaced as far away from the actual electrodes 11 as is necessary. Other drive mechanisms such as belts and chains will be obvious to the skilled reader. Indeed each drive tube could be driven and controlled individually if the hole requirements dictated thus.

CLAIMS

1 A flexible drive system for use in multi-electrode electrical discharge machining wherein the drive system comprises a plurality of flexible drive members for coupling to respective electrodes and drive means for rotating the drive members and each electrode about its longitudinal axis.

2 A drive system as claimed in claim 1 wherein the flexible drive members are tubular for use with tubular electrodes to allow the passage of dielectric fluid therealong.

3 A drive system as claimed in claim 1 or 2 wherein one end of each drive member is secured to one end of a connecting sleeve, the other end of which is adapted to receive a respective electrode.

4 A drive as claimed in claim 3 wherein each connecting sleeve is made of a material which, when mechanically deformed at a temperature below a specific temperature, returns to a predetermined shape when the temperature is raised above said specific temperature, such that below said specific temperature each connecting sleeve expands to permit assembly to the respective electrode, and above said specific temperature contracts so as to grip said respective electrode.

5 A drive system as claimed in claim 4 wherein said material is a memory metal, being an alloy of nickel and titanium.

6 Apparatus for electrical discharge machining

comprising a plurality of electrodes, the positions of which relative to the work piece are adjustable to form a machining gap, dielectric supply means for supplying dielectric fluid into the regions of the machining gap, power supply means connected in use between the electrodes and the work piece and arranged when operative to produce machining pulses for electrical discharge machining, and a flexible drive system comprising a plurality of flexible drive members for coupling to respective electrodes, and drive means for rotating the drive members and each electrode about its longitudinal axis.

7 A flexible drive system for use in multi-electrode electrical discharge machining, substantially as hereinbefore described with reference to figures 1 and 2 or figure 3 of the accompanying drawings.

8 Apparatus for electrical discharge machining, substantially as hereinbefore described with reference to figures 1 and 2, or figure 3 of the accompanying drawings.

Published 1992 at The Patent Office, Concept House, Cardiff Road, Newport, Gwent NP9 1RH. Further copies may be obtained from Sales Branch, Unit 6, Nine Mile Point, Cwmfelinfach, Cross Keys, Newport, NP1 7HZ. Printed by Multiplex techniques ltd, St Mary Cray, Kent.